Analysis of WIMAX Handover

Rambir Joon, Sandeep, Manveen Singh Chadha

Abstract: WIMAX is Wireless Interoperability for Microwave Access. It is a telecommunication technology that provides wireless data over long distances in several ways, from point-to-point links to full mobile cellular type access. The main consideration of Mobile Wimax is to achieve seamless handover such that there is no loss of data. In Wimax both mobile station (MS) and base station (BS) scans the neighbouring base stations for selecting the best base station for a potential handover. Two types of handovers in wimax are: Hard handover (break before make) and Soft handover (make before break). To avoid data loss during handover we have considered soft handovers in this paper. We have proposed a technique to select a base station for potential soft handover in Wimax. We have developed a base station selection procedure that will optimize the soft handover such that there is no data loss; handover decision is taken quickly and thus improving overall handover performance.
We will compare the quality of service with hard handover and soft handover. We have analysed the proposed technique with an existing scheme for soft handover in Wimax with simulation results.

Keywords: IEEE 802.16e, Hard Handover, Soft Handover.

I. INTRODUCTION

IEEE 802.16 standard defines the air interface for fixed Broadband Wireless Access (BWA) systems to be used in WMANs (Wireless Metropolitan Area Networks), commonly referred to as Wimax (Worldwide Interoperability for Microwave Access). The original standard IEEE 802.16 does not support mobility and for this purpose IEEE 802.16e-2005 was introduced.[1] It is
also known as Mobile Wimax . It is the new mobile version of the older Wimax

Specification known as IEEE 802.16e-2004 which is wireless but fixed, it lacks the ability for user to move during data transmission. The main purpose of Wimax is to provide users in rural areas with high speed communications as an alternative to expensive wired connections (e.g. cable or DSL). That is Wimax is capable to provide high speed internet to last mile connections. But this is not the only purpose of Wimax systems. Mobile Wimax allows the user to move freely during data transmission. The main consideration of mobile Wimax is that there should be no data loss when the moving user switches from one base station to another i.e. during handover. Handover is procedure when a mobile station changes the serving base station. The reason for handover could be relatively low signal strength or work load of base station.[3]

Wimax is a state-of-the-art wireless technology which utilizes adaptive modulation and coding, supports single carrier (SC) and orthogonal frequency division multiplexing techniques (OFDM) and several frequency bands for different operation environments. WiMAX system is able to constantly monitor the quality of the radio channel and change its operational parameters (e.g. modulation and coding) accordingly.

II. MOBILE WIMAX

In communication industry, the mobile use of devices is increasing rapidly. Mobility is in trend. Users want to have access to same services as provided by traditional wired technology (high speed internet: broadband) no matter where they happen to be. So we need a mobile device that provides seamless high speed broadband access to users, which is provided by mobile Wimax.

The development of network supporting mobility requires the ability of a device to change the serving base station according to the movement of the user. This procedure called handover has to be performed without any disturbance in the connection that is without any data loss and maintaining the confidentiality between the MS and BS's. A very likely usage scenario could be a user travelling in a car which means that the communication and handovers is needed to be supported even when the car is moving with high speed. Another consideration with mobile device is limited power resources. The batteries can carry only certain amount of charge and needs to be recharged on regular basis.

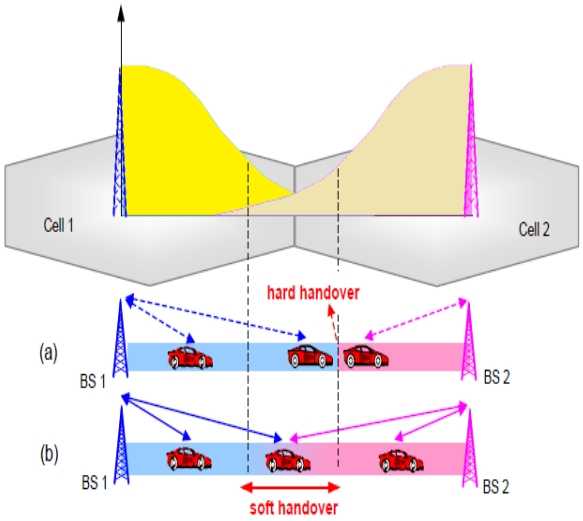

Fig 1.1 Handovers

Manuscript received on July 09, 2011

Mr. Rambir Joon, Electronics & Communication, Jagannath University, Jaipur, India.
Mr. Sandeep, Electronics & Communication, Jagannath University, Jaipur, India.
Mr. Manveen singh Chadha, Electronics & Communication, Jagannath University, Jaipur, India.

III. HANDOVERS IN WIMAX

A special requirement of a mobile device is the ability to change its serving base station if there exists another base station with better signal strength in the reach of mobile station (MS). Handover is a procedure that provides continuous connection when a MS migrates from the air-interface of one BS to another air-interface provided by another BS without disturbing the existing connections. Handovers are needed to support mobility.

For a handover to occur, one needs to have at least two base stations, serving base station (SBS) and target base station (TBS). The handover is generally considered as change in serving base station but it does not necessarily mean that the base station must be changed. In some cases there may be different reasons why a handover might be conducted.

When the MS is moving away from the area covered by one cell and enters the area covered by another cell the connection is transferred to the second cell in order to avoid data loss when the MS gets outside the range of the first cell. When the capacity for connections of a given cell is used up, the new connection which is located in an area overlapped by another cell, is transferred to that cell in order to free-up some capacity in the first cell for other users, who can only be connected to that cell.

When the channel used by the MS becomes interfered with by another MS using the same channel in a different cell, the call is transferred to a different channel in the same cell or to a different channel in another cell in order to avoid the interference.

Signal strength is not enough for maintaining proper connection.

Behaviour of MS changes, for example in case of fast moving MS suddenly stopping; the large cell size can be adjusted by a small size cell with better capacity.

IV. TYPES OF HANDOVERS

There are two types of handovers used in cellular network systems: hard handover and soft handover.

A. Hard Handover

The hard handover is used when the communication channel is released first and the new channel is acquired later from the neighbouring cell. For real-time users it means a short disconnection of communication. Thus, there is a service interruption when the handover occurs reducing the quality of service. Hard handover is used by the systems which use time division multiple access (TDMA) and frequency division multiple access (FDMA) such as GSM and General Packet Radio Service (GPRS) [35].

B. Soft handover

The soft handover, in contrast to hard handover, establishes multiple connections with neighbouring cells. Soft handover is used by the code division multiple access (CDMA) systems where the cells use same frequency band using different code words. Each MS maintains an active set where BSs are added when the RSS exceeds a given threshold and removed when RSS drops below another threshold value for a given amount of time specified by a timer. When a presence or absence of a BS to the active set is encountered soft handover occurs. The systems using soft handoff are Interim Standard 95 (IS-95) and Wideband CDMA (WCDMA).

V. METHODS OF SOFT HANDOVERS IN WIMAX

A. Macro Diversity Handover (MDHO)

The MDHO supported by MS and by BS, the "Diversity Set" is maintained by MS and BS. The Diversity Set is a list of the BSs, which are involved in the handover procedure. The Diversity Set is maintained by the MS and BS and it is updated via MAC (Medium Access Control) management messages. A sending of these messages is usually based on the long-term CINR (Carrier to Noise plus Interface Ratio) of BSs and depends on two thresholds: Add Threshold and Delete Threshold. Threshold values are broadcasted in the DCD (Downlink Channel Descriptor) message. The Diversity Set is defined for each MS in the network. The MS continuously monitors the BSs in the Diversity Set and defines an "Anchor BS". The Anchor BS is one of the BSs from Diversity Set in MDHO. The MS is synchronized and registered to the Anchor BS, further performs ranging and monitors the downlink channel for control information. The MS communicates (including user traffic) with Anchor BS and Active BSs in the Diversity Set[1]

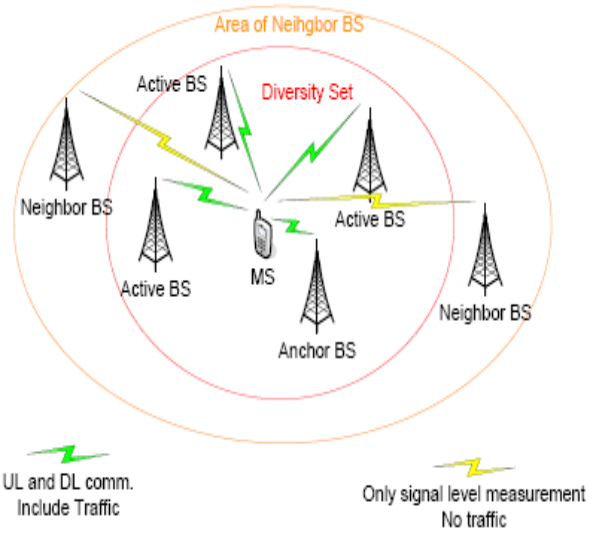

Fig 1.2 Macro Diversity handover

B. Fast Base Station Switching (FBSS)

We are considering fast base station switching technique. In this method a diversity set is maintained for each mobile station. The serving base station and mobile station monitors the neighbouring base stations that can be added in diversity set. Diversity set is maintained by both mobile station and serving base station. Diversity set is collection of base stations that can chosen as target base station for a handover. The mobile station selects one base station from diversity set as anchor base station sends its current location to it which is sent to base station controller for decision of a handover. Whenever there is a need of

handover base station controller sends handover initiation message to mobile station. Handover decision can be taken by mobile station, base station or base station controller depending upon the implementation [1].

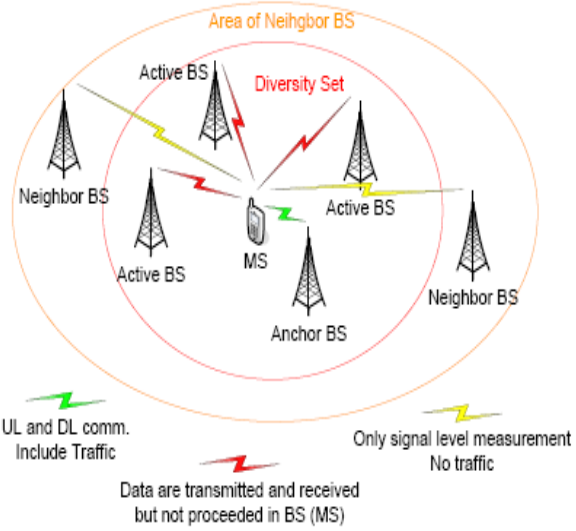

Fig.1.3 Fast Base Station Switching (FBSS)

V. SIMULATION AND RESULT

The proposed technique is implemented in NS-2.34 Simulator in Linux environment. We have modified ns-2.34 by adding mac802.16-e layer to it for supporting Wimax. The wimax.tcl file is coded on c++, when executed it generates a .nam file which can be viewed in Network Animator tool of ns2 simulator. This simulation.nam file visualizes the soft handover procedure

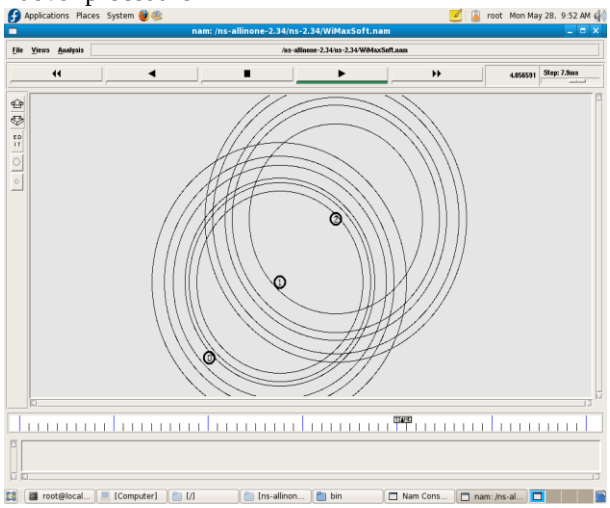

Fig. 1.4 Nam file for Soft Handover

Fig 1.4 shows 3 nodes used in simulation of base station selection procedure for soft handover. Here node 1 is mobile station and all the other nodes are base stations. The simulation shows the handover procedure as mobile station changes its position.

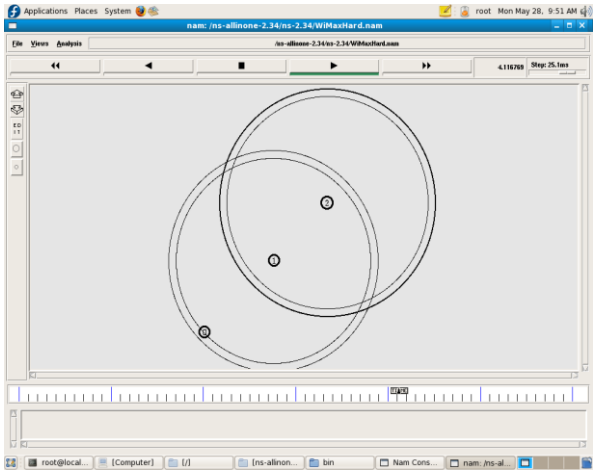

Fig.1.5 Nam File For Hard Handover

Above figure shows the ranging between node 0 and node 1. The node 0 acts as serving base station for mobile station (node 1). The node 1 starts data communication with node 0.

As the mobile station moves, its distance from serving base station increases and the mobile station looks for another base station for soft handover ie. Target Base Station. The above figure shows handover when the mobile station connects with target base station. Node 2 is target base station.

First result is comparison between the fast base station switching handover and our proposed technique. It shows that using the proposed technique the performance of soft handover is improved.

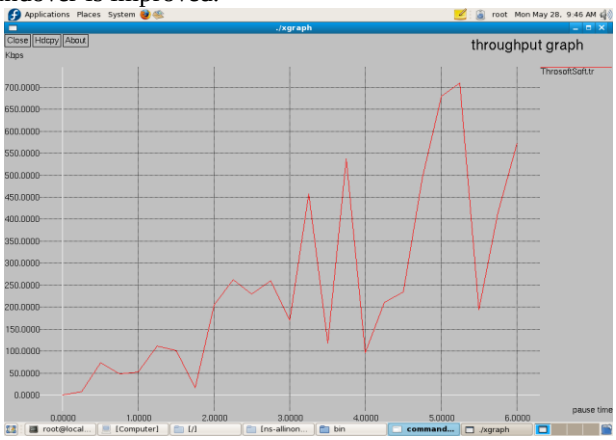

Fig. 1.6 Graph of Soft Handover

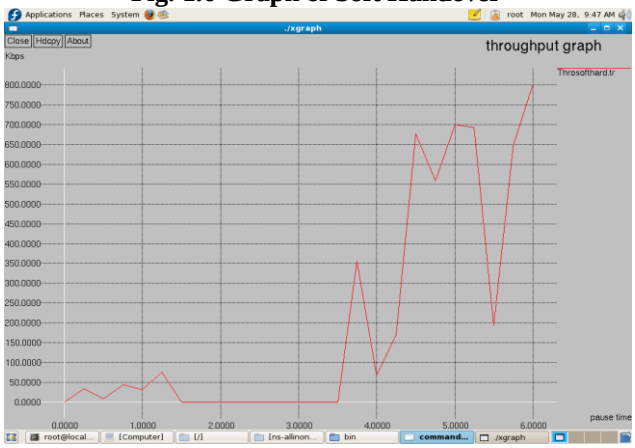

Fig. 1.7 Graph for the Hard Handover

The x axis denotes the time and y-axis denotes the packet received.Second result is round trip time calculated for three nodes (or base station). This shows how far the base station is from mobile station. The x axis denotes trip time and y axis denotes number of nodes. The node that has minimum round trip time is nearest to mobile station and hence is best option for being target base station.

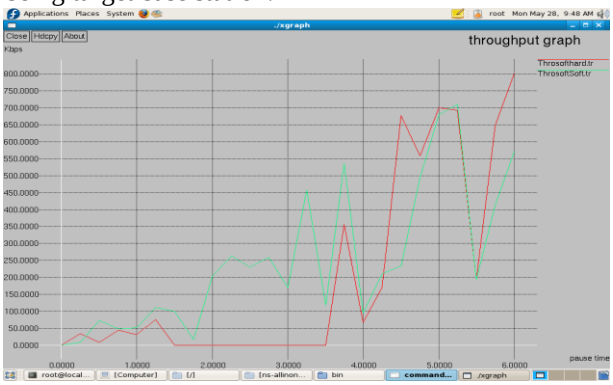

Fig. 1.8 Comparison of Soft and Hard Handover

VII CONCLUSION AND FUTURE WORK

The purpose of this paper work is to study the basic concepts of cellular handover and the handover latency with the travelling speed of mobile station in mobile WiMAX networks. Currently the WiMAX standard states that hard handover is compulsory. Macro diversity handover and fast base station switching are both optional. Hence hard handover is the focus of this work.

We simulated the more realistic handover in the mobile WiMAX using NS-2 with WiMAX and mobility modules. The goal of this simulation is to find out the relationship between the handover latency and the velocity of mobile station. It can be seen that the current handover mechanics used in the NS-2 module meets the requirement of seamless handover in mobile WiMAX when the mobile station travel at the speed of 20 m/s. Although, using link-going down mechanism will dramatically reduce the handover latency, it is still a challenge to achieve the full mobility: up to 120 km/h, handover latency of less than 50 ms with an associated packet loss that is less than 1 percent.

As extension to this research work, two topics for future research investigations are suggested. Since there is a trade off between handover threshold and margin, an adaptive threshold window could be used to balance the load of base station and the QoS of the mobile. If the handover happens early before mobile entering the coverage of the target base station, the target base station has to allocate some resources to the call entry and it also causes unnecessary handovers. But, if the handover happens too late, the QoS will be hard to maintain due to the low SINR and interference from other cells. This is a potential research topic by selecting the threshold window (the gap between threshold and hysteresis margin) adaptively according to the SINR of the mobile station senses.

Also, the current work is restricted to hard handover only. Possibilities of extending this work to macro diversity and fast base station switching can be worthy of an investigation. Although these are soft handover techniques and currently optional in the WiMAX standard, the BS selection procedure based on location predication algorithms and current load factors of the target BSs give an alternat*ive* way of deciding the target BS. Further, reducing the number of handovers is highly desirable from a system perspective.

REFERENCE

1. Zdenek Becvar, Jan Zelenka, Implementation of Handover Delay Timer into WiMAX, (http://fireworks.intranet.gr).
2. IEEE P802.16e/D12, “Air Interface for Fixed and Mobile Broadband Wireless Access Systems: Amendment for Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands”, October 2005.
3. Arpan Mandal, Mobile wimax: pre-handover optimization using hybrid Base Station selection procedure, University of Canterbury, 2008.
4. Andrews, J. G., A. Ghosh, Fundamentals of WiMAX : Understanding broadband wireless networking, Prentice Hall ,et al. (2007).
5. T. Bchini, N. Tabbane, E. Chaput, S. Tabbane and A-L. Beylot, Performance of Soft Handover – FBSS Compared to Hard Handover in case of High Speed in IEEE 802.16e for Multimedia Traffic, 5th International Conference: Sciences of Electronic, Technologies of Information and Telecommunications March 22-26, TUNISIA 2009.
6. IEEE Std: “Air Interface for Fixed and Mobile Broadband Wireless Access Systems,” IEEE 802.16e, Part 16, February 2006.
7. Hyang Duck Cho, JaeKyun Park, Keumsang Lim, Jongha Kim, Wooshic Kim,The Mobile Controlled handover method for Fixed Mobile Convergence between WLAN, CDMA and LAN.
8. Liu, Zhou,Challenges and Solutions for Handover Issues in 4G Wireless Systems, An Overview.
9. Yue Chen Soft Handover Issues in Radio Resource Management for 3G WCDMA Networks,2003.
10. WiMAX Forum. “WiMAX End-to-End Network Systems Architecture,” Draft Stage 2: Architecture Tenets, Reference Model and Reference Points, June 2007.
11. Youngbin Im, Hakyung Jung, Ji Hoon Lee, Vertical Handovers in Multiple Heterogeneous Wireless Networks: A Measurement Study for the Future Internet.
12. Zdenek Becvar, Jan Zelenka ,Handovers in the Mobile WiMAX.
13. Michael Carlberg Lax and Annelie Dammander ,WiMAX - A Study of Mobility and a MAC-layer Implementation in GloMoSim.
14. N. P. Singh , Brahmjit Singh, Performance Enhancement of Cellular Network Using Adaptive Soft Handover Algorithm.

AUTHORS PROFILE

Mr. Rambir Joon
Received his B.Tech from S I T M , Rewari Affiliated from M.D.U. Rohtak & M.Tech from JaganNath University, Jaipur, in 2008 & 2012 in Electronics & Communication. His field of interest include Digital system Design, Wireless Communication And Mobile Communication**.**

Mr. Sandeep
Received his B.Tech from Gurgaon Institute of Technology and Management affiliated from MDU, Rohtak & M.tech from Jagannath University, Jaipur in 2009 and 2012 in Electronics and Communication. His field of interest includes Wireless and Mobile communication.

Mr. Rambir Joon
Received his B.Tech from S I T M , Rewari Affiliated from M.D.U. Rohtak & M.Tech from JaganNath University, Jaipur, in 2008 & 2012 in Electronics & Communication. His field of interest include Digital system Design, Wireless Communication And Mobile Communication**.**